



**Faculty of Information and Communication Technology**

**THE DEVELOPMENT AND TESTING OF EDUCATIONAL GAME  
IN PROBLEM BASED LEARNING IN LEARNING MATHEMATICS.  
(PBLMath)**

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Technology**

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**THE DEVELOPMENT AND TESTING OF USING EDUCATIONAL GAME IN  
PROBLEM BASED LEARNING IN LEARNING MATHEMATICS. (PBLMath)**

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## DECLARATION

I declare that this thesis entitles “The Development and Testing of Educational Game in Problem Based Learning in Learning Mathematics (PBLMath)” is the result my own research except as cited in the references. This thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : .....

## APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Information and Communication Technology.

Signature : .....

Supervisor Name : **ASSOC. PROF. DR. FAAIZAH BINTI SHAHBODIN**

Date : .....

## DEDICATION

To my beloved family,

Rosli bin Md Dali, Musānif bin Miswandi, Farhan, Fahmi and Faris

For my supervisors,

Assoc Prof Dr. Faaizah Shahbodin and co-supervisor Dr. Gede Pramudya Anantha

(UTeM)

Lastly to my beloved friends who are encouraged, guided and inspired me. Without their patience, understanding, support and most love, the completion of this work would not have been possible. Special thanks also to all who contributed to complete row of this thesis.

## ABSTRACT

Problem Based learning (PBL) is increasingly used in many disciplines. PBL can be defined as a pedagogical strategy for posing significance, contextualized, real world situations, providing resources, guidance, instruction to learners as they develop content knowledge and problem solving skills. This research on Problem Based Learning focused on the testing of educational game in Problem Based Learning on Mathematic learning. The objectives of this research is (1) to evaluate the effectiveness of using game in PBL in term of developing problem solving skills and (2) to evaluate the effectiveness of using PBL in term of students' achievement. The course entitled Engineering Mathematics 2 which covers the Related Rates topic constitutes a compulsory for students in Engineering programmes. Phase one is Analysis which includes literature survey and collection of preliminary analysis data. Second Phase is Designing and Development which adopt ADDIE model as a basis for multimedia development. The last phase is Testing and Evaluation. A total of 53 students involved in this research that are in first year of study from one of Polytechnic in Malaysia. The respondent were divided into two groups namely control group and experiment group. Both groups were given a set of pre-test. Three phases involved in this research methodology. There are five research instruments gathered to evaluate the project which are prototype of PBLMath, problem solving sheet, problem solving rubrics, pre-test and post-test questions. The prototype called PBLMath is developed to support the effectiveness of teaching and learning. A t-test was conducted to analysed independent variables by PBL and non PBL treatment while students' problem solving skills and students' achievement are dependent variables. Finding of this study revealed that the students who use game are more competent in (i) identifying diagram and sketches ( $M=3.88$ ,  $SD=0.34$ ), (ii) knowing how to use mathematical terminology and notation correctly ( $M=3.69$ ,  $SD=0.47$ ) and (iii) connecting logical connections between facts and concepts in mathematics ( $M=3.63$ ,  $SD=0.50$ ). Lastly this study has showed that the use of PBL is significantly related to improve students' achievement with the average score of PBLMath group was 73.57 ( $SD=15.27$ ) compared to non PBLMath group.



## ABSTRAK

Pembelajaran Berasaskan Masalah (PBL) semakin digunakan dalam pelbagai disiplin. PBL boleh ditakrifkan sebagai satu strategi pedagogi bercirikan adanya permasalahan nyata sebagai konteks pembelajaran, model yang menyerupai keadaan dunia sebenar, menyediakan panduan, arahan dan sumber kepada pelajar agar mereka dapat membangunkan pengetahuan dan berkemahiran dalam penyelesaian masalah. Kajian ini memberi tumpuan kepada ujian permainan pendidikan dalam Pembelajaran Berasaskan Masalah dalam pembelajaran matematik. Objektif kajian ini ialah (1) untuk menilai keberkesanan penggunaan permainan pendidikan dalam PBL dalam meningkatkan kemahiran penyelesaian masalah dan (2) menilai keberkesanan menggunakan PBL dari segi pencapaian pelajar. Kajian ini menjurus kepada kursus Matematik Kejuruteraan 2 yang merangkumi topik "Related Rates". Ia merupakan kursus wajib bagi pelajar program kejuruteraan. Tiga fasa terlibat dalam metodologi kajian ini. Fasa satu adalah analisis yang merangkumi kajian literature dan pengumpulan data analisis awal. Fasa kedua adalah merekabentuk dan pembangunan perisian kursus yang menguna pakai model ADDIE sebagai asas bagi pembangunan multimedia. Fasa yang terakhir ialah pengujian dan penilaian. Seramai 53 orang pelajar yang terlibat dalam kajian ini merupakan pelajar tahun pertama pengajian dari salah satu politeknik di Malaysia. Responden ini dibahagi kepada dua kumpulan iaitu kumpulan kawalan dan kumpulan eksperimen. Kedua-dua kumpulan diberi satu set ujian pra. Terdapat lima instrument kajian digunakan untuk menilai projek iaitu prototaip PBLMath, kertas jawapan penyelesaian masalah, rubrik penyelesaian masalah, soalan ujian pra dan ujian pos. Prototaip yang dipanggil PBLMath dibangunkan untuk menyokong keberkesanan penggunaan PBL dalam pengajaran dan pembelajaran. Ujian-T dijalankan bagi tujuan analisa dengan pembolehubah bebasnya adalah kumpulan PBL dan bebas PBL manakala kemahiran penyelesaian masalah dan pencapaian pelajar adalah pembolehubah bersandar. Dapatan kajian ini menunjukkan bahawa pelajar yang menggunakan permainan adalah lebih kompeten dalam (i) mengenalpasti rajah dan lakaran ( $M=3.88$ ,  $SD=0.34$ ), (ii) mengetahui bagaimana untuk menggunakan istilah matematik dan notasi dengan betul dan ( $M=3.69$ ,  $SD=0.47$ ), (iii) mengaitkan hubungan logic antara fakta dan konsep dalam matematik ( $M=3.63$ ,  $SD=0.50$ ). Akhir sekali kajian ini telah menunjukkan bahawa penggunaan PBL adalah signifikan dengan meningkatkan pencapaian pelajar dengan skor purata kumpulan PBLMath adalah 73.57 ( $SP = 15.27$ ) berbanding dengan kumpulan tanpa PBLMath.

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## **LIST OF ABBREVIATIONS**

<b>ADDIE</b>	Analysis, Design, Development, Implementation & Evaluation
<b>CRIM</b>	Centre Research & Innovation Management
<b>JMSK</b>	Jabatan Matematik Sains dan Komputer
<b>NCTM</b>	National of Council of Teachers of Mathematics
<b>PBL</b>	Problem Based Learning
<b>PMM</b>	Politeknik Merlimau Melaka
<b>SPSS</b>	Statistical Package for Social Science
<b>TIMSS</b>	Trends in International Mathematics and Science Study
<b>UTeM</b>	Universiti Teknikal Malaysia Melaka

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## CHAPTER 1.

### INTRODUCTION

#### 1.1 Introduction

In meeting global needs, it is important to produce knowledge workers in science and technology. This requires graduates who are knowledgeable and skilled in mathematics. Nevertheless, most university students find that learning mathematics is difficult and tedious, resulting in poor performance in students' achievement (Floyd, R.G., et al., 2003; Costu, S., S. Aydın and M. Filiza, 2009; Suthar, V. and R. Ahmad Tarmizi, 2010). Many students do not like to learn mathematics and often perceive mathematics as an unpleasant experience and that it is hard to learn the subject (Ali, R., 2010; Tarmizi, R.A., 2013). Mathematics is usually taught in conventional ways that result in information becoming uninteresting, irrelevant and disconnected to students' experiences (Sam, H.K., et al., 2009; Ahmad Tarmizi, R. et al., 2010; Zakaria, E., et al., 2010). Thus, this paves the way towards an ever-growing population of individuals with mathematical anxiety (Sam, H.K., et al., 2009). It is therefore important to identify and recognize the factors that could enhance students' mathematics achievement in order to help them to improve and make substantial academic progress. This research in the technology on education aims to look into PBL and Game as a way to support the teaching and learning of mathematics and improve learning.



PBL is one of the important approaches in education nowadays (George, 2002; Akinoglu, 2007; Abdullah et al., 2010). Earlier research (Chang, 2001; Khairiyah et. al, 2005; Akinoglu,2007; Cazzola,2008; Abdullah et al., 2010) has written that PBL learning environment gives students the opportunity to examine and try out their previous knowledge, discover what they need to learn, develop skills while solving problems, improve communication skills, state and defend with sound arguments and evidence on their own ideas, and become more flexible in their approach to solve.

In a research conducted by Abdullah (2010), he has demonstrated that PBL is an instructional approach where students are confronted with a real problem and challenged to work towards a solution. In order to solve the problem, students will have to engage in a variety of activities such as analyzing a problem, gathering information and forming solutions. As students tackle these activities, the students have more opportunities to think critically and present creative ideas and communicate with peers through the mathematical activities (Abdullah and Zakaria et al., 2010). In such a way, PBL may build intrinsic motivation among students as it has been proven by Costu (2009) and Mokhtar et al. (2010) that PBL has a positive effect on academic achievement and attitudes toward students' development.

The significance of PBL in education cannot be denied. With the entry of technology into the classroom, the teaching of mathematics has changed. Morali (2010) claim that educational technologies that are well-designed could complement and support the learning environment. The challenge of creating and integrating educational technologies to enhance the PBL environment has been an issue. The technology enables teachers to be creative and enthusiastic with the resources available that could help them to implement various techniques and strategies into the classroom to make learning more

meaningful and interesting to students (George, 2002). In addition, with the advent of technology-rich teaching on a large scale, there are now many new opportunities for creative and innovative teaching. Thus this builds a new relationship that shapes students in a shifting world of knowledge. The development of technology in recent years has prompted changes in teaching and learning strategy, especially in higher education.

Games are seen as a model that can improve learning environments by providing the elements of goals, challenges, and collaboration. Games provide students with the opportunity to learn while engaging in a competition. By stepping away from the conventional methods of decades past, games are often significantly more effective in promoting student involvement in the lesson. Game keeps the students tuned in to the lesson and learning throughout the activity. Hence, incorporating game in PBL, it can attract students in the learning process (Papastergiou, 2009) and improve the quality teaching and learning (Alan et al., 2000; Gros, 2007; Hromek, 2009; Ishikan, 2010).

## **1.2 Background of study**

Many studies have been and are still being conducted on problem-based learning. The PBL method starts with a problem to be solved; students working in a PBL environment must become skilled in problem solving, creative thinking and critical thinking. Proponents of PBL believe that when students develop methods for constructing their own procedures, they are integrating their conceptual knowledge with their procedural skill (Kashefi et al., 2011). The studies generally compare the problem based learning environment with traditional educational environments. Unfortunately, there are a small number of studies in problem-based learning dealing with a comparison of using game and non-game environments.

Research findings have indicated that for most engineering students, mathematics has always been one of most difficult courses to study (Abdullah, 2010; Tarmizi, 2012). Many students struggle as they encounter non-routine problems that are not solved by routine problem solving methods. The limitation of traditional ways of teaching mathematics is associated with teacher-oriented instruction and the “ready-made” mathematical knowledge presented to students who are not receptive to the ideas (Choenfeld et al., 1998; Chang et al. and Uzel, 2012). In these circumstances, students are likely to imitate the procedures without deep conceptual understanding. Ishikan and Kebritchi (2010) agreed that when mathematical knowledge or procedural skills are taught before students have conceptualized their meaning, students’ creative thinking skills are likely to be stifled by instruction.

Results for the past three years reveal that students in Politeknik Merlimau, Melaka, failed to achieve good results in Engineering Mathematics 2. A preliminary analysis was done at the early stage of the research. From December 2010 to June 2012 (for 3 semesters), the percentage of the failure rate was high as shown in Table 1.1. Based on the early stage analysis, it was revealed that one of the factors that caused the failure was poor achievement in Related Rates topic. Students agreed that the topic was the most difficult topic to understand and control. The results of students’ perception on the hardest topic are shown in Appendix A



Table 1.1: Key Performance Indicators for BA201 Course from December 2010 to June 2012

Study Session	Dec 2010			June 2011			Dec 2011			June 2012		
Course Code												
BA 201 Engineering Mathematics	No of students	% Pass	% Fail	No of students	% Pass	% Fail	No of students	% Pass	% Fail	No of students	% Pass	% Fail
	442	60	40	482	65	35	475	60	40	555	62	38

Source: Politeknik Merlimau examination data

These findings were supported by the analysis of the examination data that showed students were less interested in answering question on Related Rates topic. For those who tried to answer the question failed to achieve average marks. The result is as shown in Table 1.2.

Table 1.2: Students' Achievement in Question on Related Rates

Session	Number of students who attempted Question on Related Rates		Number of students who <b>achieved</b> above average marks		Number of students <b>achieved below</b> average marks	
Total number of students who enrolled in BA201						
<b>Dec 2010 session</b> 442 students	180	40%	25	14%	155	86%
<b>Jun 2011 session</b> 482 students	172	35%	40	23%	132	77%
<b>Dec 2011 session</b> 475 students	185	38%	32	17%	153	83%
<b>June 2012 session</b> 555 students	138	27%	40	29%	98	71%

In a study of students' difficulties in solving Related Rates problems conducted by (Martin, 2000; Mokhtar et al., 2010; Tarmizi, 2012), they concluded that the poor performance of students is related to the difficulties of understanding both procedures and conceptual knowledge in mathematics. Learning Related Rates usually provides students with a list of steps that need to be followed for solving the problem without leading students to a mastery of knowledge and procedural knowledge (Engelke, 2007). Thus, this

study aims to improve students' skills in problem solving as well as to make them excel in their academic achievement.

### **1.3 Problem Statement**

The main goal of the teaching and learning of mathematics is to develop the ability to solve mathematical problems. The problem solving process involves an exploratory phase and understanding develops through the problem solving process. According to National Council of Supervisors of Mathematics (NCTM, 2000), learning to solve problems is the principal reason for studying mathematics. To mathematically literate people, mathematics problem solving is synonymous with doing word problems, creating patterns, interpreting the figures, developing geometric constructions and proving theorems.

Today, Polytechnic's students fail to achieve high score in Engineering Mathematics 2 subject. It is due to a weak level of proficiency in problem solving. If we ignore this problem; student failure rate will be higher and thus affect the quality of Polytechnic graduates. This research was conducted on mathematics learning specifically in the learning of the topic of Related Rates. The topic was chosen because of the difficulties of the topic in the Engineering Mathematics 2 course in the Polytechnic. This research combines the use of PBL and educational game to support mathematics learning.

### **1.4 Objectives of study**

Problem Based Learning study combines educational game sessions to enhance student learning and interest in mathematics. The game embedded combines the elements of procedural and content knowledge for mastering mathematics' problem solving. It is



used as one of the sources of learning in PBL. This study aims to improve students' learning with the following goals:

- i. To develop a problem based learning courseware using educational game based learning approach for learning mathematics.
- ii. To measure the effectiveness of using game and PBL in terms of students' problem solving in mathematics learning;
- iii. To measure the effectiveness of using PBL in mathematics learning based on academic achievement.

In order to pilot this study, the specific research questions guiding the research were as follows:

- i. Is there any significant difference in problem solving in mathematics ability between PBLMathGame group and the non PBLMathGame group?
- ii. Is there any significant difference in students' achievement in terms of academic achievement between PBLMath group and the non PBLMath group?

## **1.5 Hypothesis**

A hypothesis is a tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation. In this study, to answer the research questions triggered, 2 null hypotheses will be observed:

- i. There is no significant difference between the PBLMathGame group and the non PBLMathGame group in their problem solving ability.
- ii. There is no significant difference between the PBLMath group and the non PBLMath group in their mathematics achievement.